REMARKS

Claims 1-3, 6-14, 16, 18, 21-29, 31 and 36-45 are currently pending in this application. Applicants reserve the right to pursue the original and other claims in this and other applications. Applicants respectfully request reconsideration of the above-referenced application in light of the following remarks.

Claims 1-3, 6, 8, 9, 11-14, 16, 18, 21, 23, 24, 26-29, 31, 36, 38, 39 and 41-45 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Wang et al. (U.S. Patent No. 6,376,309) ("Wang") in view of Hoff et al., "Atomic Oxygen and the Thermal Oxidation of Silicon" ("Hoff"), or Ruzyllo et al., "Evaluation of Thin Oxides Grown by the Atomic Oxygen Afterglow Method" ("Ruzyllo"). The rejection is respectfully traversed and reconsideration is respectfully requested.

Claim 1 recites a method of forming a flash memory cell including the acts of "forming a tunnel oxide," "forming a first conductor layer," and "forming an insulating layer." Forming the insulating layer further includes the steps of "forming a first oxide layer," "forming a nitride layer," and "forming a second oxide layer ... in a single processing step ... at a temperature of about 850°C to about 1100°C, for about 1 second to about 10 minutes, with a gas ambient containing atomic oxygen." According to claim 1, "said second oxide layer formed by said single processing step results in a deposited thickness of from about 20 Å to about 80 Å thick." The method further recites, "forming a second conductor layer over said insulating layer" after said single processing step.

Claim 16 recites a method of forming an ONO insulating structure including the acts of "depositing a first oxide layer," "depositing a nitride layer," and "forming a second oxide layer ... in a single processing step ... using a gas ambient containing

atomic oxygen, wherein ... the second oxide layer formed by said single processing step has a deposited thickness of at from about 20 Å to about 80 Å thick."

Claim 31 recites a method of forming a flash memory array including the acts of "forming a tunnel oxide," "forming a first conductor layer," and "forming an insulating layer." Forming the insulating layer further includes the steps of "forming a first oxide layer," "forming a nitride layer," and "forming a second oxide layer in a single processing step ... grown in the presence of atomic oxygen at a temperature of about 850°C to about 900°C for a period of about 1 second to 10 minutes." According to claim 31, "said second oxide layer formed by said single processing step has a thickness of from about 20 Å to about 80 Å thick." The method further includes the step of "forming a second conductor layer over said insulating layer" after said single processing step.

Applicants respectfully submit that the cited combination does not disclose, teach, or suggest all of the limitations of the above claims. Specifically, the cited combination does not disclose the second oxide layer being formed on a nitride layer in a single processing step using a gas ambient containing atomic oxygen, at a temperature from about 850°C to about 1100°C, in a time frame of about 1 second to about 10 minutes, resulting in a deposited thickness of from about 20 Å to about 80 Å thick.

The Office Action acknowledges that "Wang et al. fails to show forming the second oxide layer using an oxidizing ambient in atomic oxygen to form the oxide layer." Office Action at page 3. The Office Action relies upon Hoff or Ruzyllo for disclosing the act of forming the second oxide layer by means of an oxidizing ambient using atomic oxygen. *Id.* Applicants respectfully submit that these references are not properly combinable with Wang for purposes of the obviousness determination.

Additionally, Applicants respectfully submit that even if the references were properly combinable, Hoff and Ruzyllo do not disclose the method of forming the oxide layer of the claimed invention.

First of all, Applicants respectfully submit that it is improper to combine the references in the manner suggested by the Office Action. Obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found in the references themselves. In re Fine, 837 F.2d 1071, 5 USPQ.2d 1596 (Fed. Cir. 1988). Applicants respectfully submit that there is no suggestion or motivation in any of the references themselves for combining them to arrive at the claimed invention.

The Office Action states that "the motivation to combine the references is clearly stated in the ... rejection." Office Action at page 5. Applicants respectfully disagree. The alleged motivation to combine provided in the Office Action states, "it would have been obvious ... to modify the process of Wang ... because both [the Hoff and Ruzyllo] processes allow for oxide growth at low temperatures with high breakdown values. Furthermore, the process of [Hoff or Ruzyllo] also uses atomic oxygen so one would expect similar results with respect to the thickness." Office Action at pages 3-4. Applicants respectfully submit that the Office Action is using impermissible hindsight by using the claims of the present invention as a road map to improperly combine the references. See Ex parte Clapp, 227 U.S.P.Q. 972, 973 (Bd. App. 1985); M.P.E.P. §2144. The alleged motivation to combine stated in the Office Action provides no support from the references themselves as to why one using the process of Wang would modify it to use the process of Hoff or Ruzyllo.

Wang relates to a method of forming a flash memory device. The flash memory device of Wang includes a conventional ONO insulating layer structure. The creation of this structure is a conventional deposited oxide, deposited silicon nitride and then a thermal oxidation of the silicon nitride via steam ambient at high temperature. The use of steam ambient is the obvious choice for the top oxidation as it is the least expensive and most cost effect manner in which to oxidize silicon nitride. This is not, however, the method of lowest thermal budget. It is commonly known that thermal oxidation of silicon nitride is not highly effective thus requiring high temperatures and long processing times.

Ruzyllo and Hoff disclose low temperature plasma (atomic oxygen) processes for oxidation of silicon, not nitride. The references discuss experiments with using atomic oxygen (instead of atmospheric oxygen) for the oxidation of silicon. However, Ruzyllo and Hoff do not disclose, teach or suggest that atomic oxygen can be used for oxidation of a nitride. In fact, the Ruzyllo reference discusses adverse impacts of using a nitrogen-containing afterglow gas. See e.g., Ruzyllo, Abstract and page 377. This discussion in Ruzyllo, regarding nitrogen having an adverse affect on the process, teaches away from using the atomic oxygen method for oxidation of a nitride layer.

Additionally, the reaction of the invention, atomic oxygen with nitride, produces unexpected results. For example, use of thermal oxidation is such that if a silicon wafer and a silicon wafer with silicon nitride were oxidized at the same conditions (950 °C, 40 minutes in steam), the oxide grown on the silicon nitride would be only 10-20% of the thickness of the oxide grown on silicon (e.g., five to ten times the amount of oxide is grown on silicon as would be grown on silicon nitride under the same conditions). On the other hand, the reaction with atomic oxygen is such that if a silicon wafer and a silicon wafer with silicon nitride were oxidized at the same conditions in atomic oxygen ambient, the thermal oxide grown on the silicon nitride

would be 40-60% of the thickness of the silicon oxide grown on silicon. This is not discussed by Ruzyllo or Hoff and thus it would not have been obvious to replace the relatively cheap thermal oxidation of silicon nitride with the expensive atomic oxygen single wafer – batch systems discussed in Hoff and Ruzyllo, since the expected results (of much thinner oxide growth) would not be worth the expense.

The criteria for determination of obviousness is whether the prior art would have "suggested to one of ordinary skill in the art that this process should be carried out and would have a reasonable likelihood of success, viewed in the light of the prior art." In re Dow Chemical Co., 837 F.2d 469, 473 (Fed. Cir. 1988). "Both the suggestion and the expectation of success must be founded in the prior art, not in the applicant's disclosure. ... In determining whether such a suggestion can fairly be gleaned from the prior art, the full field of the invention must be considered; for the person of ordinary skill is charged with knowledge of the entire body of technological literature, including that which might lead away from the claimed invention." *Id.* The cited references do not provide the suggestion to combine and the expectation of success needed to render obvious the use of the method for atomic oxygen oxidation of silicon, discussed in Hoff and Ruzyllo, to grow an oxide on a nitride layer, as in the claimed invention.

Even if the references could be combined, despite any motivation to do so, it is well-settled that "[t]he mere fact that references can be combined or modified does not render the resultant combination obvious unless the prior art also suggests the desirability of the combination." M.P.E.P. § 2143.01. The prior art does not suggest the proposed combination; but, rather the claimed invention is the foundation for the combination. As noted above, the references teach only using atomic oxygen for growing an oxide on silicon. They do not disclose, teach or suggest using atomic oxygen for growing an oxide on nitride. Again, the proposed combination is improper hindsight reconstruction.

Secondly, Applicants respectfully submit, that the Office Action fails to set forth a *prima facie* case of obviousness. *See* M.P.E.P. § 2142. "To establish *prima facie* obviousness of a claimed invention, all the claim limitations must be taught or suggested by the prior art." M.P.E.P. § 2143.03.

The cited references, even if combinable, do not teach or suggest at least a second oxide layer being formed on a nitride layer in a single processing step using a gas ambient containing atomic oxygen, at a temperature from about 850°C to about 1100°C, in a time frame of about 1 second to about 10 minutes, resulting in a deposited thickness of from about 20 Å to about 80 Å thick. For example, with regard to the thickness limitation, the Office Action states that in Wang "the second oxide layer is formed by oxidizing said nitride layer to a thickness of fifty angstroms in a single process step." Office Action at page 3. However, the Office Action further states that the second oxide layer is being formed by the method of Hoff or Ruzyllo. *Id*. The thickness of the oxide layer formed in Wang cannot be used to disclose the claimed invention if this oxide layer is being replaced by the oxide layer of Hoff or Ruzyllo. Hoff or Ruzyllo do not disclose an oxide layer of the claimed thickness that can be formed on a nitride in a single processing step in the claimed time period.

The Hoff and Ruzyllo references also do not disclose an oxidation time of "about 1 second to about 10 minutes" as recited in claims 1, 16 and 31. In fact, these references disclose a much longer "5 minute to 2 hour" time period for the oxidation process. The Office Action asserts that "[w]ith respect to the particular time and temperature of the oxidation, it would have been obvious to determine through routine experimentation the optimum time and temperature to conduct the oxidation process based upon a variety of factors including the desired thermal budget and would not lend patentability to the instant application absent the showing of unexpected results." Office Action at page 4. However, the shorter oxidation time, as claimed, would not

have been obvious from the cited references because, according to the disclosure of the references, the claimed thicknesses could not be achieved in the shorter time periods. Finally, Hoff and Ruzyllo teach oxidation of silicon. There is no indication that the same technique could be used to oxidize nitride or that a nitride would oxidize to the thickness claimed under the claimed process conditions.

Applicants also respectfully submit that the combination of Wang with Hoff or Ruzyllo does not address the limitations of at least dependent claims 11-14, 26-29 and 41-44. The combination of Wang with Hoff or Ruzyllo does not disclose, teach or suggest forming the second oxide layer in a single wafer system, in a batch furnace system, in a rapid thermal system or in a fast ramp system.

Accordingly, claims 1, 16 and 31 are allowable over the cited combination. Claims 2-3, 6, 8, 9 and 11-14 depend from claim 1 and are allowable along with claim 1. Claims 18, 21, 23, 24 and 26-29 depend from claim 16 and are allowable along with claim 16. Claims 36, 38, 39 and 41-45 depend from claim 31 and are allowable along with claim 31. Applicants respectfully request that the rejection of claims 1-3, 6, 8, 9, 11-14, 16, 18, 21, 23, 24, 26-29, 31, 36, 38, 39 and 41-45 be withdrawn and the claims be allowed.

Claims 7, 10, 22, 25, 37 and 40 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Wang in view of Hoff or Ruzyllo and further in view of Neely et al. (U.S. Patent No. 5,443,863) ("Neely"). The rejection is respectfully traversed and reconsideration is respectfully requested.

Independent claims 1, 16 and 31 are allowable over Wang in view of Hoff or Ruzyllo, for at least the reasons discussed above. Neely is relied upon as disclosing forming the second oxide layer through photoexcitation or using ozone and does not

remedy the deficiencies of the Wang/Hoff/Ruzyllo combination as to claims 1, 16 and 31.

Accordingly, claims 1, 16 and 31 are allowable over the cited combination. Claims 7 and 10 depend from claim 1 and are allowable along with claim 1. Claims 22 and 25 depend from claim 16 and are allowable along with claim 16. Claims 37 and 40 depend from claim 31 and are allowable along with claim 31. Applicants respectfully request that the rejection of claims 7, 10, 22, 25, 37 and 40 be withdrawn and the claims be allowed.

In view of the above, Applicants believe the pending application is in condition for allowance.

Dated: February 21, 2007

Respectfully submitted,

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